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L4: Entry 17 of 26 File: USPT Jun 27, 2000

DOCUMENT-IDENTIFIER: US 6080526 A
TITLE: Integration of low-k polymers into interlevel dielectrics using controlled electron-beam radiation

Brief Summary Text (9):
It has now been discovered that the properties of certain spin-on dielectric films used in IC interconnect processing are improved when those films are cured with a controlled electron beam radiation treatment when compared to a thermal cure. Thus, for example, the invention provides improved methods for achieving non-etchback process for spin-on low-k dielectrics using controlled electron beam radiation processes. The invention also provides improved methods for protecting the underlying dielectric layer from process environment induced degradation, particularly dielectric constant of certain spin-on low-k polymer films using a controlled electron beam radiation process. The invention also provides improved methods for retaining the intrinsic dielectric constant for spin-on polymer films in areas such as in between metal lines using controlled electron beam radiation process.

Brief Summary Text (10):
It has been discovered that if a freshly deposited spin-on dielectric film is exposed to an electron beam radiation under relative low energy conditions, subsequent to standard hotplate treatments, then a "skin" is formed as the outer layer of the film which has been most directly contacted by the electron beam radiation. The thickness of this "skin" can be regulated by the electron beam energy levels, including the time duration of exposure, and the integrated (total) electron beam dosage delivered to the film. Thus, the film can be only lightly cured such that a thin skin of nominally 500-6000 angstroms can be formed, depending on the interlayer dielectric thickness. A continuum of extents of cure for the films can be thus be advantageously used in semiconductor processing. A relatively brief cure in which a skin is formed simultaneously allows retention of the low dielectric constant of the film, attainment of a hardened, oxidation resistant outer layer on the film, and minimization of process time when compared to the electron beam radiation cure of the full thickness of the film. With this process, the original homogeneous dielectric layer can be converted into two distinctive layers. The dielectric layer on the top of metals is significantly modified and thus some of its properties have been significantly changed. This layer has such excellent properties as low or no moisture absorption and low or no degradation upon exposure to high temperature and oxygen plasma environments, and thus a non-etchback process can be achieved without degradation. The underlying dielectric layer, particularly in between-metal lines, retains its intrinsic dielectric properties such as low dielectric constant. The modified top layer protects the underlying dielectric layer and thus the properties of the underlying dielectric is not affected by high temperature and oxygen plasma exposure.

Detailed Description Text (34):
Silicon wafers were coated using conventional spin-coating with a solution comprising either a methyl silsesquioxane polymer and a mixture of organic solvent or a hydrogen silsesquioxane polymer and a mixture of organic solvent. The coated wafers were subjected to successive hot plate treatments followed by either thermal curing, partial e-beam curing or full e-beam curing. Table 4 shows the conditions for this experiment with detailed conditions for bake, thermal cure and e-beam cure. Aluminum dots with thickness of about 1 micron and diameter of 0.5 mm were coated on